(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 137 644**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 84305522.9

(22) Date of filing: 14.08.84

(51) Int. Cl.⁴: A 61 F 13/18
A 61 L 15/00

(30) Priority: 15.08.83 US 523473
15.08.83 US 523474
15.08.83 US 523501

(43) Date of publication of application:
17.04.85 Bulletin 85/16

(84) Designated Contracting States:
AT BE CH DE FR IT LI LU NL SE

(71) Applicant: PERSONAL PRODUCTS COMPANY
Van Liew Avenue
Milltown New Jersey 08850(US)

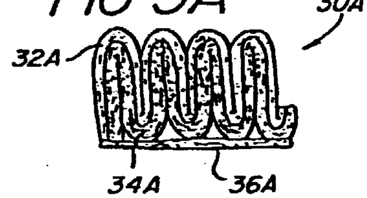
(72) Inventor: Holtman, Dennis C.
Box 125 RD 5 Old Clinton Road
Flemington New Jersey 08822(US)

(74) Representative: Jones, Alan John et al,
CARPMAELS & RANSFORD 43 Bloomsbury Square
London, WC1A 2RA(GB)

(54) Corrugated web structure.

(57) An absorbent product comprising a corrugated fibrous and superabsorbent in an amount of at least 10 percent by weight associated with the web. The corrugated web is stabilized to retain its transverse folds when wet.

FIG-3A



EP 0 137 644 A2

Corrugated Web Structure

Background of the Invention

The present invention relates to new and improved corrugated web structures and in addition to new and improved absorbent corrugated web structures incorporating therein superabsorbent.

Disposable absorbent products have been known for some time, including such products as disposable diapers, sanitary napkins, wound dressings, bandages, incontinence pads, and the like. These products incorporate an absorbent batt which is used to absorb and hold or contain body fluids. Initially in many of these products, especially diapers and sanitary napkins, the absorbent batt comprised what is termed "wadding" or plies of tissue. The wadding was disposed between a liquid-impermeable backing and a liquid-permeable facing and the plies of tissue were used to absorb and, hopefully, contain the liquid within the product. A diaper which utilizes such an absorbent batt is disclosed in U.S. Reissue Patent No. 26,151.

The wadding type of product was replaced, for the most part, by an improved absorbent batt which comprises what is termed "fluffed woodpulp fibers". This absorbent batt comprises a layer of individualized woodpulp fibers with the layer having substantial thickness. A diaper which incorporates such a fluffed woodpulp absorbent batt is described in U.S. Patent No. 2,788,003. This diaper had improved absorbent capacity and somewhat better containment than a diaper using a wadding layer. Also, the fluffed woodpulp layer is quite soft, flexible, and conformable, and, hence, produces an improved diaper over diapers using wadding as the absorbent layer.

Though the fluffed woodpulp absorbent batts have improved capacity, the efficiency with which the capacity is used in a diaper or sanitary napkin is poor. The reason for this is that the fluid to be absorbed is generally deposited in a localized area within the absorbent batt, and the ability of the fluid to move along the plane of the batt is poor. The fluid tends to follow a radial wicking path and consequently moves to the closest edge of the batt where it generally is no longer contained and the product leaks.

U.S. Patent No. 3,017,304 discloses an absorbent product which incorporates in the product a densified paper-like layer. This paper-like layer acts as a wick, i.e., liquid which is placed on the layer tends to move rapidly along the plane of the layer. When incorporated in combination with fluffed woodpulp fiber, the resultant product uses the absorbent capacity of the fluffed woodpulp much more efficiently. Diapers which incorporate this paper-like layer combined with fluffed woodpulp are disclosed and described in U.S. Patent Nos. 3,612,055 and 3,938,522. This concept of combining wicking ability, or a capillary skin or layer, with fluffed woodpulp fibers has gained wide acceptance in many absorbent products including disposable diapers and sanitary napkins. Even though these products make much greater use of the capacity of the absorbent batt, they still do not totally contain the absorbed liquid. It is probable that these products will leak before the full capacity of the batt is used for the absorption or, at the very least, before the entire liquid void by the user is absorbed. This is especially true when pressure is placed on the batt while wet. For example, a baby sitting down on a previously wetted diaper will very often cause the batt to leak.

An incontinent adult faces not only the problems of the infant but many other problems. First, the void of an adult generally is much higher in volume than that of an infant. Second, a bulge under clothing is accepted by society for an infant, but the ambulatory adult with an incontinence problem longs for a product which is not visible through ordinary clothing. Third, the proportions and shape of the legs and torso of the adult differs considerably from those of an infant. Therefore, a mere enlargement of an infant diaper, such as that shown in U.S. Patent 4,253,461 is not a satisfactory product.

In both the infant diaper and adult incontinence product marketplace, a product is needed which has a large storage capacity. For instance, shaped containers have been suggested. However, these containers have been substantially rigid, do not stay in place, and are quite uncomfortable. A product with a substantially large storage capacity, with an ability to move liquid away from the void zone, which is disposable, which is comfortable, and which does not show through wearing apparel is needed in the marketplace.

A number of years ago, "superabsorbent materials", i.e., materials which will absorb many times their weight of liquid, were developed. Since the development of such materials, attempts to incorporate them in absorbent products such as diapers to enhance the absorption performance of these products have been made. Theoretically, a minimum amount of superabsorbent incorporated in a product would make that product perform as well or better than the prior art products. Perhaps one of the first products to incorporate such a superabsorbent material in a disposable diaper is disclosed in U.S. Patent No. 3,670,731. This patent discloses an absorbent dressing comprising an absorbent layer sandwiched

between a permeable facing and an impermeable backing sheet. The absorbent layer contains water-insoluble cross-linked hydrocolloid polymer as the superabsorbent material.

Even though superabsorbent materials have been available for some time, they have not gained wide acceptance in absorbent products such as disposable diapers and sanitary napkins. A primary reason for this lack of acceptance of superabsorbents is failure to develop a product capable of economically utilizing the highly increased absorptive capacity of the superabsorbent material. In order to economically utilize a superabsorbent, the liquid being absorbed must be readily accepted and placed in contact with the superabsorbent material. Furthermore, as the superabsorbent material absorbs liquid, it must be allowed to swell. If the superabsorbent is prevented from swelling, it will cease absorbing liquid. Hence, if the superabsorbent material is to function in absorbent products, such as diapers and sanitary napkins, wherein the liquid to be absorbed is placed in a small void area, the structure of the absorbent layer containing superabsorbent materials must have certain characteristics. Over the years, a number of techniques have been disclosed in an attempt to provide structures which make efficient use of the superabsorbent material. Such products are disclosed in U.S. Patent Nos. 4,103,062; 4,102,340; and 4,235,237. In addition, methods for incorporating superabsorbents into suitable layers or suitable configurations which can be placed in an absorbent product, are disclosed in U.S. Patent Nos. 4,186,165; 4,340,057; and 4,364,992. To date, none of these products has met with any substantial commercial success.

The present invention provides a new and improved absorbent product which possesses a large storage capacity, which is soft and comfortable, which can be designed so as not to be apparent through normal clothing, and which, if desired, utilizes a substantial portion of the absorptive capacity of superabsorbent materials. In addition, the new absorbent product will contain absorbed liquid even when pressure is placed upon the product during use.

<u>Summary of the Invention</u>

The present invention provides a disposable absorbent product comprising a first fibrous layer in the form of a nonwoven web. A second fibrous layer discrete from the first layer but united to the first layer is provided which second layer has a higher capillary pressure than the first layer. This provides preferential wicking of liquid in the second layer. These layers, in their united form, are transversely folded to provide a corrugated structure which is stabilized in such a way as to retain its transverse folds even when wet. The absorbent product is generally stabilized on one side of the product, i.e., over the surface at the peaks of the transverse folds or in corrugations on one side thereof.

The present invention also provides an absorbent product comprising a corrugated fibrous web which contains at least about 10% by weight of superabsorbent preferably about 50-90%. The corrugated web is stabilized to retain its transverse folds even when wet. The absorbent product may be stabilized by placing a layer of a stabilizing substance on one side of the product over the surface at the peaks of the transverse folds, or by adding a minor portion of fibers having a lower melting point than the remaining fibers in the fibrous web and subjecting the

corrugated web to temperatures sufficient to melt the fibers, thereby providing heat bonding between the folds or within the corrugations.

The present invention further provides a disposable absorbent product comprising a corrugated fibrous web having associated therewith at least about 10% by weight of said web of superabsorbent. The product also comprises a liquid-impermeable barrier covering at least one side of the web, and a liquid-permeable facing covering at least the other side of the web. The corrugated web is stabilized to retain its transverse folds when wet.

The first fibrous layer comprises substantially hydrophobic, resilient, preferably synthetic fibers in the form of a nonwoven web. The second layer, if present, is comprised of fibers (or in the case of peat moss, particles) which when placed in the form of a layer provides a higher capillary pressure than the capillary pressure of the first fibrous layer. As a result, the second layer drains liquid from the first layer and wicks the liquid away from the void zone.

The superabsorbent may be of a wide particle size range and is distributed in any one of a number of ways, e.g., as a layer, or film or as individual particles or globules or as part of the web being corrugated, and is associated in each instance with the first fibrous layer.

In a preferred embodiment, the first fibrous layer is prepared in the form of a nonwoven web and the second layer is deposited by known procedures onto the first layer. The second layer is comprised of a wicking substance which provides a higher capillary pressure than that of the first layer. The wicking substance includes hydrophilic fibers such as cellulosic fibers, rayon fibers

and other wicking substances such as peat moss or mixtures thereof or acrylic fibers or the like. The wicking substance which forms the second layer generally is comprised of fibers or particles in closely spaced relationship to promote the movement of liquid along the second layer.

When the absorbent product is utilized after the transverse folding or corrugation takes place, the liquid preferentially moves along the second layer whether the second layer is vertical or horizontal. The corrugations are placed in an absorbent structure, such as a diaper or incontinence product, so as to lie parallel to the longitudinal axis of the product.

Body fluids such as urine, menstrual fluid or other fluids are deposited in a localized area on the first fibrous layer in any given area of the absorbent product. The second layer immediately commences its draining and transporting activity to remove the liquid from the localized area. As the liquid front moves horizontally, it also moves vertically, thus gradually being transferred from one transverse fold to another.

In another embodiment, the absorbent product is prepared by placing superabsorbent on the fibers of the web prior to corrugation, corrugating the web, and then stabilizing the web to retain its transverse folds even when wet.

Brief Description Of The Drawings

Figures 1 and 1A are side elevational views of portions of suitable webs for use in the present invention;

Figures 2 and 2A are side elevational views of the starting material of Figures 1 and 1A respectively after transverse folding has begun taking place;

Figures 3 and 3A are side elevational views of the material of Figures 2 and 2A respectively after corrugation and stabilizing has taken place;

Figure 4 is a perspective view illustrating one embodiment of the present invention;

Figure 5 is a side elevational view of a portion of another starting material for use in the present invention;

Figure 6 is a side elevational view of the starting material of Figure 5 as transverse folding is taking place;

Figure 7 is a side elevational view of the material of Figure 6 after corrugating and stabilizing has taken place;

Figure 8 is a perspective view of a specific embodiment of the present invention;

Figure 9 is a perspective view of another embodiment of the present invention;

Figures 10, 10A and 10B are enlarged cross-sectional views through lines 10-10 of Figure 9 depicting three different internal webs;

Figure 11 is a perspective view of a further embodiment of the present invention; and

Figure 12, 12A and 12B are cross-sectional views through lines 12-12 of Figure 11, depicting three different internal webs.

Detailed Description Of The Invention

Figure 1 represents a side elevational view of a segment of starting material 10 depicting a fibrous layer 12 having distributed therein superabsorbent 14.

Figure 2 depicts the starting material 20 in partially corrugated form wherein a fibrous web 22 contains superabsorbent 24.

Figure 3 is a side elevational view of the starting material of Figure 1 after corrugation to provide a corrugated segment of the starting material 30. The starting material 30 contains a fibrous web 32 having distributed therein superabsorbent 34 and is bonded at points 36 wherein fusible fibers have been permitted to melt to make bonding contact points. Thus, the starting material 30 is corrugated and stabilized so as to maintain its transverse folds even when wet.

Figure 1A represents a side elevational view of a segment of starting material 10A depicting a first fibrous layer 12A and a united second layer 14A prior to a transverse folding or corrugation treatment of the starting material 10A.

Figure 2A provides a side elevational view of the starting operation of corrugating the starting material 20A. The starting material 20A consists of a nonwoven fibrous web 22A, and a second layer 24A of fibers wherein the density is greater than that of the fibrous layer 22A.

Figure 3A is a perspective view of an absorbent product of the present invention. The absorbent product 30A contains a corrugated web 33A and a stabilizing substance 36A. The stabilizing substance maintains the starting material in its transversely folded or corrugated form even when the absorbent product 30A becomes wet.

Figure 4 is a perspective view of a corrugated web product 40 of the present invention. The corrugated web product 40 contains a superabsorbent distributed throughout the web and is stabilized as shown in Figure 3.

Figure 5 is a side elevational view of a segment of starting material 50 which is a fibrous web 52 but not containing any superabsorbent.

Figure 6 depicts a segment of starting material 60 such as that in Figure 5 in a partially corrugated form wherein superabsorbent 64 has been placed in the pockets of the partially corrugated web 62.

Figure 7 represents a corrugated web 70 which is the completed corrugated web of that shown in Figure 6. The web 72 has placed in the pockets of the corrugated web superabsorbent 74 and has been stabilized by a layer of a latex-type material 76 having been applied on the peaks of the corrugation on the side opposite where the superabsorbent is contained in the corrugation pockets.

Figure 8 depicts a disposable diaper 80. A moisture-pervious facing 82, such as a nonwoven fabric, provides the diaper surface. A moisture-impervious substance 84, such as polyethylene, forms the moisture-proof backing of the diaper. The diaper structure 80 contains an absorbent product 83 sandwiched between the facing 82 and the backing 84. The absorbent product 83 is that described

and shown in Figure 4. The diaper side edges are gathered in the crotch region by elastic members 87. To secure the diaper about the waist of the wearer, tape tabs 89 are provided. The diaper product 80 generally has the absorbent product 83 placed in such a manner that the corrugations run parallel to the longitudinal axis of the product.

Referring now to Figure 9, a urinary pad 90 is depicted. The urinary pad 90 has a moisture-permeable facing 92 covering the entire upper surface. Immediately beneath the facing 92 is a liquid barrier 94 which encompasses the entire product except for the opening 95 on the upper surface which lies immediately below the facing 92. The opening 95 permits ingress of fluid.

Figure 10 is an enlarged cross-sectional view of Figure 9 taken along lines 10-10. The facing 102 is the layer which is placed against the skin of the wearer. The liquid barrier 104 encompasses the absorbent product 103 except for the opening 105 wherein fluid is permitted to enter. The absorbent product 103 is similar to that depicted in Figure 7. The surface of the corrugated web opposite the stabilizing layer is placed upon the upper surface of the absorbent product 103.

Figure 10A is an enlarged cross-sectional view of Figure 9. The facing 102A is the layer which is placed against the skin of the wearer. The liquid barrier 104A encompasses the absorbent product 103A except for the opening 105A wherein liquid is permitted to enter. The absorbent product 103A is similar to that depicted in Figure 3A. The first fibrous layer is on the upper surface of the absorbent product 103A.

Figure 10B is an enlarged cross-sectional view of Figure 9. The facing 102B is the layer which is placed against the skin of the wearer. The liquid barrier 104B encompasses the corrugated web 103B containing the superabsorbent except for the opening 105B through which liquid is permitted to enter.

Figure 11 illustrates a sanitary napkin 110 having a fabric overwrap 112 which is liquid permeable.

Figure 12 depicts an enlarged cross-sectional view of Figure 11 taken along lines 12-12. The liquid permeable overwrap 121 appears with its overlapped portion on the upper surface. Immediately below is a moisture-impermeable barrier 125 which encompasses the sides and bottom of the product. The absorbent product 123 partially encompassed by the liquid barrier 125 and the overwrap 121 has a fibrous layer 122 and superabsorbent 124. The superabsorbent is placed in the pockets of the corrugation on the side opposite the stabilizing substance 126 which in turn is in contact with the liquid barrier 125. Thus, the lower surface in the drawing is the side provided for the entry of the fluid.

Figure 12A depicts an enlarged cross-sectional view of Figure 11. The liquid permeable overwrap 121A appears with its overlapped portion on the upper surface. Immediately below is a moisture-impermeable barrier which encompasses the sides and bottom of the product. The absorbent product 123A partially encompassed by the liquid barrier 125A and the overwrap 121A has a fibrous layer 122A and a wicking layer 124A. The wicking layer 124A is in contact with the stabilizing substance 126A which in turn is in contact with the liquid barrier 125A. Thus, the lower surface in the drawing is the side provided for entry of the fluid.

Figure 12B depicts an enlarged cross-sectional view of Figure 11. The cross-sectional portion of product 120B is provided with a liquid-permeable overwrap 121B appearing with its overlapped portion on the upper surface of the drawing. Immediately below is a moisture-impermeable barrier 124B which encompasses the sides and the bottom of the product. The corrugated web consists of a fibrous web layer 126B and another layer 128B which layer has a higher capillary pressure than the fibrous web layer 126B. Superabsorbent 125B is placed in the pockets created by the base of the corrugations of the web and the liquid-impermeable backing 124B. The superabsorbent is substantially trapped in this pocket. The overwrap 122B provides the facing on the lower surface in the drawing. The facing 122B is placed against the skin of the wearer.

These and other products such as incontinence pads, wound dressings, wipes and the like may be made from the absorbent product depicted in Figure 4 or segments of which are depicted in Figures 3 and 7.

The first fibrous web used to provide the corrugated fibrous web is generally of substantially high loft and upon dry compression followed by release has a tendency to return substantially to its original thickness. For instance, fibrous webs formed from synthetic fibers such as polyethylene, polypropylene, polyester, nylon (polyamide fibers), bi-component fibers, mixtures thereof and the like are particularly suitable. However, cellulosic fibers such as rayon may be used. Generally, the fibers are carded to form a web which is then stabilized if needed. Stabilization may be achieved by heat-through bonding, adhesive bonding, point embossing with heat or adhesive or both, and the like. The stabilizing process is selected according to the fibers used and the process used to form the web. Other suitable

procedures forming a web including air-laying, wet-laying, spun bonding, laying of melt-blown fibers and other known techniques. The fibrous web before corrugation, preferably has a dry bulk of at least about 10 cc. per gram, and a weight less than about 4 oz. per square yard.

In one embodiment, wherein superaborbent is used, a blend of staple polyester fibers with a minor portion of fusible fibers, such as lower melt polyester fibers, are carded to form a web. The web is subsequently lightly bonded by passing hot air through the fibers making the fusible fibers tacky so as to stick to each other and the staple fibers to provide the desired degree of integrity to the web structure.

The superabsorbent, present either on the fibers of the web or placed in the folds of the corrugated web, or otherwise associated with the web, is generally a water-insoluble, water-swellable polymeric substance capable of absorbing water in an amount which is at least 10 times the weight of the substance in its dry form. The super-absorbent is in the form of fibers, spheres, particles, bits of film, globules, webs, film or the like, or may be applied in the form of a liquid monomer solution which is subsequently polymerized. The superabsorbent prepared by polymerization of a monomer solution placed on fibers in a web is most frequently in the form of globules and bits of film-like particles in the web structure.

One type of superabsorbent material provides particles or fibers which may be described chemically as having a backbone of natural or synthetic polymers with hydrophilic groups or polymers containing hydrophilic groups being chemically bonded to the backbone or in intimate mixture therewith. Included in this class of materials are such modified natural and regenerated polymers as polysac-

charides, including for example, cellulose and starch and regenerated cellulose which are modified by being carboxyalkylated, phosphonoalkylated, sulfoalkylated, or phosphorylated to render them highly hydrophilic. Such modified polymers may also be cross-linked to improve their water-insolubility.

These same polysaccharides may also serve, for example, as the backbone on to which other polymer moieties may be bonded by graft copolymerization techniques. Such grafted polysaccharides and their method of manufacture are described in U.S. Patent No. 4,105,033 to Chatterjee et al. and may be described as polysaccharide chains having grafted thereon a hydrophilic chain of the general formula:

$$-\left[\begin{array}{ccc}(CH_2)_q & - & CR^1 \\ & & | \\ & & C = O \\ & & | \\ & & A\end{array}\right]_r- \cdot -\left[\begin{array}{ccc}(CH_2)_p & - & CR^2 \\ & & | \\ & & C = O \\ & & | \\ & & B\end{array}\right]_s-$$

wherein A and B are selected from the group consisting of $-OR^3$, $-$ O(alkali metal), $-OHNH_3$, $-NH_2$, wherein R^1, R^2, and R^3 are selected from the group consisting of hydrogen and alkylene having 1 to 4 or more carbon atoms wherein r is an integer having a value of 0 to about 5000 or more, s is an integer having a value of 0 to about 5000 or more, r plus s is at least 500, p is an integer having a value of 0 or 1, and q is an integer having a value of 1 to 4. The preferred hydrophilic chains are hydrolyzed polyacrylonitrile chains and copolymers of polyacrylamide and polysodium acrylate.

In addition to the modified natural and regenerated polymers, the hydrocolloid component may comprise wholly synthetic hydrophilic particles. Examples of those now known in the art are polyacrylonitrile fibers which may be modified by grafting moieties thereon such as polyvinylalcohol chains, polyvinyl alcohol itself, hydrophilic polyurethane, poly(alkyl phosphonates), partially hydrolyzed polyacrylamides (e.g., poly(N-N-dimethylacrylamide), sulfonated polystyrene, or a class of poly(alkyleneoxide). These highly hydrophilic synthetic polymers may be modified by other chemical treatments such as cross-linking or hydrolysis. Further examples known in the art are the non-ionic polymers such as polyoxyethylene, polyoxypropylene, and mixtures thereof which have been suitably cross-linked, either chemically or by irradiation. Still another more recent type is a derivative of isobutylenemalic and acrylate monomers, such as sodium, potassium, ammonium, (or a combination of cations), acrylate, may be placed on the absorbing layer by spraying or otherwise placing a solution thereon, followed by polymerization and cross-linking, for example, by irradiation.

In addition, naturally occurring materials such as gums may be used. Examples of such suitable gums include guar gums, acacia gums, locust bean gums and the like.

The superabsorbent is combined with the web in such a manner as to remain substantially in the same position or region even though the web may be moved about during manufacturing, packaging, or use. The superabsorbent is combined with the fibrous web either before or after corrugation by any means suitable preferably to place the superabsorbent so as to try to minimize interference by one superabsorbent particle or fiber or the like with another upon the swelling of the first. If the

superabsorbent material is a powder, it may be sprinkled on to the fibrous web either in dry form or the web may be moistened or the powder may be placed into a transverse fold of the corrugated web. If the superabsorbent is in granular form, it may be desirable to slightly moisten the superabsorbent before placing it in contact with the web. The superabsorbent generally will be in the form of particles or fibers or globules or the like which may range in size from about 0.0005 mm. in diameter to globules that are continuous along fibers for a distance of several inches.

Another method of placing superabsorbent in a fibrous web is by spraying a monomer solution on the web or perhaps even saturating the web with a monomer solution, followed by polymerization of the monomer. One typical way to polymerize the monomer is by use of irradiation. It is desirable to place a superabsorbent somewhat evenly throughout the fibrous web. However, even if the superabsorbent is powder-like and in the form of a layer, it tends to function better in the present corrugated web than in previously known products.

Any superabsorbent which absorbs large amounts of liquids is suitable for use in the absorbent product of the present invention.

Corrugating or transverse folding of the web is carried out by known procedures such as that exemplified in U.S. Patent 4,111,733. The web corrugations range from about three to about six or even eight per inch of corrugated web. The corrugated web is generally from about 1/4 to about 3 inches preferably from about 1/2 to about one inch thick.

After or during corrugating of the fibrous web, the corrugated structure is stabilized to prevent the corrugations from pulling apart and flattening out either in the dry form or when becoming wet. One method of stabilizing the web is accomplished by using an adhesive binder which may be a latex resin or other known adhesive. A typical way to stabilize the corrugated web is to spray an adhesive on one corrugated surface thereof and, if necessary, curing the adhesive by heat or permitting it to dry. The non-stabilized surface is open and available to fan apart to place superabsorbent therein and also will easily receive fluids. Another method of stabilizing the web is by adding a small portion of fusible fibers to the web fibers before the web is made. These fusible fibers have a lower melting point than the remaining fibers and when the corrugated web is subjected to temperatures sufficient to melt the fusible fibers, light bonding is provided between the corrugations.

In order for the fibrous web to provide the most desired medium for receiving and holding liquid, it is preferred that the fibrous web have a dry bulk of at least about 10 cc. per gram and a weight of less than about 4 ounces per sq. yd. prior to corrugation preferably from about 1-2 ounces per sq. yd. The dry bulk is the area times thickness of the web (prior to corrugation) under a load of 0.01 psi calculated in cubic centimeters. This value is divided by the weight in grams in order to provide the measurement in cubic centimeters per gram. It has been found that using a corrugated web as the provider of void volume to contain body fluids has many advantages. For instance, fibers may be used to form the web that in the non-corrugated web form do not have enough wet resilience to retain void volume when the web becomes wet. Corrugating of the web provides the highly desirable resilience in the product that is required to initially

accept and hold a high volume of fluid. Also it has been found that superabsorbent may be randomly distributed in small or large quantities within the web with surprisingly high utilization of the superabsorbent. It is theorized that the wet resilience of the corrugated web permits the void volume to remain available almost in totality when large quantities of fluid are present in the web. This would permit the superabsorbent to swell, as it captures the liquid, without substantial inhibition.

In another embodiment of the present invention, an absorbent product is provided which comprises two layers which are corrugated. The product contains the fibrous web previously discussed, and united with it, but yet discrete from it, is a second layer which has a higher capillary pressure than the fibrous web to provide preferential attraction and wicking of liquid in the corrugated web product. In other words, in this embodiment the corrugated web consists of two layers, one of which is the fibrous web discussed before, and the other of which is a second layer united with the first layer but discrete from it. The second layer is comprised of fibers (or in the case of peat moss, particles) which, when placed in the form of a layer, provides a higher capillary pressure than the capillary pressure of the first fibrous layer. As a result, the second layer drains liquid from the first layer and wicks the liquid away from the void zone. The superabsorbent is placed as before so as to be in contact with the second layer; that is, either between the layers before the layers are corrugated or in the pockets of the corrugated web next to the second layer. In addition, the superabsorbent in the present embodiment can be placed between the two layers. In a typical example of preparation of such a structure, the first fibrous layer is formed and superabsorbent is distributed on that layer. The superabsorbent may be in

the form of bits of film, particles, globules, powder, and the like. The second layer is deposited by known procedures on to the first layer on the side on which the superabsorbent has been distributed. The second layer is united, at least in part, to the first layer by known techniques such as by use of adhesive, by use of vacuum to cause some of the fibers of the second layer to partially integrate with the first layer, by light compression, and the like. The two at least partially united layers are corrugated to form the absorbent product. In typical use, the first fibrous layer of the corrugated absorbent product is exposed to the initial impact of the liquid to be absorbed. This initial reception region must be able to accept liquid rapidly and at the same time be able to bear the liquid load even with body weight pressure applied until the second layer with its higher capillary pressure drains a substantial portion of the load and begins wicking the liquid away to another part of the product. The superabsorbent requires time to absorb liquid and swell. The corrugated web holds the liquid and permits the superabsorbent to act.

What appears to be only a small difference in capillary pressure is all that is required for the second layer to attract and drain the first fibrous layer of liquid the latter has received. The force causing a liquid to enter a cylindrical capillary is expressed by the equation

$$P = \frac{(2\gamma \cos \theta)}{r}$$

wherein the force is represented by the capillary pressure and

P is the capillary pressure,
γ is the surface tension of the liquid,
θ is the liquid-fiber contact angle, and
r is the capillary radius.

With a given liquid, the pressure (capillary force) increases with the cosine of the liquid-fiber contact angle (reaching a maximum where the angle is zero) and also increases with narrower capillary radii so that narrower capillaries will draw liquid from wider ones.

The relative wickability between the first fibrous layer and the second layer is affected by both the relative densities of the layers and the relative wettability of the individual fibers in each layer. The individual fibers of the second layer have substantially smaller liquid-fiber contact angles than those of the first fibrous layer overcoming the density difference and providing a significant overall increase in capillary pressure to absorb liquid into the second layer.

The second layer fibers (or particles) and the density of the layer are selected to create a significant difference in capillary pressure from the first fibrous layer.

The second fibrous (or particle) layer is generally comprised of fibers having a lower liquid-contact angle or wherein the layer is provided with a narrower capillary radii. Examples of such fibers include hydrophilic fibers such as rayon fibers, cellulosic fibers, or peat moss, or mixtures thereof, or acrylic fibers, or the like. Cellulosic fibers include wood pulp fibers, cotton linters and the like.

The wood pulp fibers generally are those that are used to form the fluff or fibrous batt layer in conventional

absorbent products such as disposable diapers, sanitary napkins, etc. Other cellulosic fibers that might be used are rayon fibers, flax, hemp, jute, ramie, cotton, and the like. The fiber, or peat moss, or mixtures thereof are placed in such a way as to form a layer in which the particles are close to one another so as to promote wicking of liquid in the plane of the layer.

The second layer can be preformed and placed next to the first fibrous layer or, the particles (fibers or peat moss or mixtures thereof) can be air-laid, wet-laid, or otherwise combined with the first fibrous layer before the transverse folding or corrugating takes place.

Corrugating or transverse folding of the web, whether it be a single layer or double layer web, is provided by known procedures such as that exemplified in U.S. Patent 4,111,733.

After or during corrugating of the web, the corrugated structure is stabilized to prevent the corrugations from pulling apart and flattening out. One method of stabilizing the web is accomplished by using an adhesive binder which may be a latex resin or other known adhesive. A typical way to stabilize the corrugated material is to spray an adhesive on one corrugated surface thereof. Generally the surface selected for the stabilizing, if it is a two layer structure, is a surface where the second layer is present. The non-stabilized surface is open and available to receive fluids. Another method of stabilizing a web is to add a minor portion of fibers having lower melting points than the remaining fibers in the layer and subject the corrugated web to temperatures sufficient to melt the fusible fibers thereby providing light bonding between the corrugations.

Examples of methods of preparing an absorbent product of the present invention are as follows. These examples are not intended to be limiting in any way and extensions and modifications thereof, without departure from the spirit and scope of the invention, will become apparent from these examples.

Example I

A web is formed of polyester fibers by dry-laying the fibers, i.e., by air-laying or carding the fibers to form a web. Specifically, the polyester fibers contain a minor portion of fusible fibers which are also polyester fibers of having a lower melting point. The specific polyester fibers used are identified as Type 676 manufactured and sold by E.I. DuPont blended with 10-15% fusible fibers. The web is heat-bonded by passing air at a temperature of about 275°F. through the web for a few seconds. The resulting web is 25 grams per sq. meter, basis weight. The web is coated by flooding it with an aqueous solution containing 38 percent solids. The solids are 90 percent sodium acrylate and 10 percent acrylic acid. Vacuum in the amount of 1 inch of mercury is used to withdraw the excess solution from the web. The web is then subjected to 6 megarads of electron beam radiation after which about 70 grams per sq. meter of polysodiumacrylate is present. The web is again flooded, subjected to vacuum treatment, and irradiated to yield a total of about 140 grams per sq. meter of polysodiumacrylate. A third time after flooding and the vacuum treatment, the web is subjected, this time, to 12 megarads of electron beam radiation to polymerize and cross-link the monomer and form polysodium-acrylate affixed to the polyester fiber. The final amount of polysodium acrylate present is about 200 grams per sq. meter. This is equivalent to about 800% dry-add-on. The coated polyester web is then corrugated according to known procedures.

After corrugation, the web is again subjected to temperatures in the range of 275°F. so as to again make the fusible fibers soft to provide bonding between the corrugations. The corrugations are about 3/4 of an inch high and constitute approximately 4 per inch of corrugated web. A section of corrugated web 3 inches by 7 inches will absorb up to 150 milliliters of liquid.

Example II

The same polyester fibrous web which was formed in Example I is used in Example II. The web is corrugated again providing corrugations approximately 3/4 of an inch high and in number four per inch of corrugated web. The web is then stabilized by application of a latex type adhesive resin identified as Nacrylic 78390, manufactured and sold by National Starch and Chemical Corporation in an amount of about 2% by weight of the web on one side of the corrugations of the web. The adhesive is allowed to cure providing a web stabilized on one side. On the other of the web, the corrugations are temporarily spread apart and superabsorbent identified as Permasorb 10 manufactured by National Starch & Chemical Corporation is deposited in the corrugation pockets in an amount of about 0.5 gram per corrugation pocket throughout the top of each individual corrugation. The product is then ready for use, and it is found that it contains up to about 5 mililiters of fluid per sq. inch of corrugated web.

Example III

An absorbing layer is formed of polyester fibers by dry laying the fibers i.e., by air-laying or carding to form a web. Specifically the polyester fibers contain a minor portion, about 10 to 15% by weight, of fusible fibers which soften at a lower temperature than the rest of the

fibers. The specific polyester fibers used are identified as Type 676 fibers manufactured and sold by E.I. DuPont Company. Acrylic fibers are deposited onto the polyester web to form a discrete but gently-united layer of acrylic fibers. The two layer flexible longitudinal web is subjected to corrugating in accordance with the procedures set forth in U.S. Patent No. 4,111,733 and heating to a temperature of about 275°F for a few seconds. The corrugating provides a final product having a thickness of approximately 3/4 inch weighs about 13 oz/yd^2 and having approximately four corrugations per inch. The corrugations are provided transversely to the web.

Example IV

Bicomponent fibers consisting of polyester surrounded by polypropylene in a core sheath relationship are air-laid to form a nonwoven web which is heat bonded by subjecting the web to heat for a few seconds at about 275°F. The resulting web is 25 grams per square meter, basis weight. The web is passed beneath a hammermill that deposits chemically treated wood pulp fibers onto the web. Vacuum is applied under the web so as to cause some of the pulp fibers to at least partially migrate into the nonwoven web. The major portion of the wood pulp fibers reside on the surface providing a layer containing wood pulp fibers of 50 grams per square meter. The formed structure is lightly compressed and then corrugated in accordance with the procedure used in Example I. After the web has been corrugated, it is stabilized by spraying an elastomer solution onto one surface of the corrugated web. Preferably, this surface is the surface of the wood pulp fibers. The aqueous dispersion of the elastomer is cured and the product is stabilized. The stabilized corrugated product is ready for use.

Example V

A disposable diaper similar to that depicted in Figure 8 is assembled using a polyethylene backing sheet and a polyester nonwoven fabric as the facing sheet. The absorbent core is provided by a section of the absorbent product of Example I measuring 8 inches wide and 13 inches long. The diaper is assembled by known techniques utilizing hot-melt adhesive to adhere the absorbent core to the backing, and the facing and backing to each other in the side and end margins. The resulting product will contain up to at least about 200 ml of urine.

Example VI

A urinary pad to be worn by an adult is prepared by utilizing a soft, liquid-impermeable shell which is boat-like in shape. A corrugated web, like that of Example IV, is prepared substantially the same except that the web is corrugated to a height of one inch. A section of corrugated web is shaped by cutting it to fit into the shell (see Figure 9) so that the corrugations run lengthwise. The corrugated web section is placed in the shell with the polyester web side up and a polyester liquid-permeable facing is placed over the corrugated web and adhered to the edge of the shell. Suitable means for adhering the bottom of the shell to the user's underclothing is provided. When being used, the urinary pad is placed so that the wide portion is at the front of the crotch. The urinary pad will contain at least about 200 ml of urine.

Example VII

A fibrous web is formed of polyester fibers, the fibers being staple fibers except for about 10-15% of fusible polyester fibers, the latter having a melting point of

about 275°F. The web is formed by carding the fibers. The web is heat-bonded lightly by passing air, having a temperature of about 275°F , through the web for a few seconds. The resulting web is about 25 grams per sq. meter basis weight. The specific polyester fibers used are identified as type 676 Dacron, and type 581 Dacron fibers manufactured and sold by E.I. duPont & Company. The flexible longitudinal web is subjected to corrugating in accordance with the procedure set forth in U.S. Patent 4,111,733 and subjected to heat to a temperature of about 275°F during or subsequent to corrugation in order to again render the fusible fibers sufficiently tacky to adhere to themselves and to the staple fibers of the web in order to stabilize the corrugated web.

The corrugating provides a final product having a thickness of approximately 3/4 inch and which weighs about 13 oz. per yd. in its corrugated form. There are approximately four corrugations per inch. A powdered superabsorbent polymer is uniformly sprinkled into the pockets created by the corrugation of the nonwoven polyester fibrous web. The superabsorbent is present at a concentration of about 400 grams per sq. meter of web. The particular superabsorbent used is identified as Permasorb #10, manufactured by National Starch and Chemical Corporation. The corrugated fiber web containing the superabsorbent is placed on a polyethylene film wherein the film extends at least one inch beyond the corrugated web on each side of the web. Polyester facing in the form of a nonwoven polyester fiber web having a weight of about 0.7 oz/sq. yd is placed over the corrugated web and extends beyond it on all sides by at least one inch. The polyethylene backing and the polyester facing are adhered to each other by use of hot melt adhesive on all four sides to provide a unitary disposable absorbent product. The product, when prepared

in a size of approximately 12 in by 12 in , will hold up to at least about 200 milliliters of urine when the urine is discharged onto the facing at least about 3 inches from the edge of the product.

Example VIII

The same polyester fibrous web formed in Example I is subjected to flooding with an aqueous solution of 38% solids, the solution solids being 90% sodium acrylate and 10% acrylic acid. The resulting flooding substantially coats the fibers of the web with the aqueous solution. Vacuum in the amount of 1 inch of mercury is used to draw the excess solution from the web. The web is then subjected to 6 megarads electron beam radiation after which about 70 grams per sq. meter of polysodium acrylate is present. The web is again flooded subjected to vacuum and irradiated with 6 megarads of electron beam radiation to yield a total of about 140 grams per sq. meter of polysodium acrylate. After flooding a third time with the same monomer solution and after the vacuum treatment, the web is subjected to 12 megarads of electron beam radiation which polymerizes and cross-links the monomer and forms polysodium acrylate substantially affixed to the polyester fibers of the web. Approximately 200 grams/sq. meter of polysodium acrylate is present in the substrate. This is equivalent to about 800% dry-add-on.

Staple acrylic fibers are deposited on the polyester web so as to create an intimate layer having a weight of about 30 grams/sq. meter of acrylic fibers. The two-layer web is subjected to heat-through bonding wherein the fusible fibers in the polyester web assist in at least partially uniting the acrylic fiber layer to the polyester web. The two-layer flexible longitudinal web is then subjected to corrugating again in accordance with the procedures set

forth in U.S. Patent No. 4,111,733. Following corrugating, the web is stabilized in its corrugated form by spraying an elastomer solution onto the surface wherein the acrylic fibers are at the peaks of the corrugation. The aqueous dispersion of the elastomer is cured and the product is thereby stabilized. The corrugated product is placed on a liquid-impermeable diaper backing and a facing is placed on the other surface. The backing and facing are united in the margins by known procedures. Tape tabs are then applied at one end of the diaper to provide a disposable diaper product which will receive and retain up to about 300 milliliters of urine.

Example IX

The corrugated web prepared in Example VIII is placed in a sanitary napkin so that the corrugations are parallel to the longitudinal axis of the sanitary napkin product. The liquid barrier is a polyethylene film and the overwrap is a polyester nonwoven fabric as described above. Adhesive lines are placed on the under side of the product an release film strips are placed over the adhesive lines. Upon removal of the release film strips, the product is readily adhered to the underclothing of the user.

From the foregoing it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of this invention.

CLAIMS

1. An absorbent product comprising a corrugated fibrous web containing at least 10% by weight of said web of superabsorbent, said corrugated web being stabilised to retain its transverse folds when wet.

2. The absorbent product of claim 1, wherein the superabsorbent is present in an amount between 10 and 150% by weight of said web.

3. The absorbent product of claim 2, wherein the superabsorbent is present in an amount between 50 and 90% by weight of said web.

4. The absorbent product of any one of claims 1 to 3, wherein the superabsorbent is substantially affixed to the fibers of the fibrous web.

5. The absorbent product of any one of claims 1 to 3, wherein the superabsorbent is placed in the folds provided by said corrugation.

6. The absorbent product of any one of claims 1 to 5 including a second layer which has a higher capillary pressure than the fibrous web.

7. The absorbent product of claim 6, wherein the second layer is discrete from but united to said fibrous web and substantially co-extensive therewith, the second layer being denser than said fibrous web to provide preferential wicking of liquid in said second layer.

8. The absorbent product of claim 6 or claim 7, wherein the superabsorbent is between the corrugations and in contact with said second layer.

9. The absorbent product of claim 6 or claim 7, wherein the superabsorbent is between said fibrous web and said second layer.

10. An absorbent product comprising a first fibrous web layer and a second layer discrete from but united to said first layer, said second layer having

a higher capillary pressure than said first layer to provide preferential attraction and wicking of liquid in said second layer, said layers being transversely folded to provide a corrugated structure, said corrugated web being stabilised to retain its transverse folds when wet.

11. The absorbent product of any one of claims 1 to 10 wherein the fibrous web prior to corrugation has a dry bulk of at least 10 cc per gram and a weight less than 4 ounces per square yard.

12. The absorbent product of any one of claims 1 to 11, wherein the fibrous web has a dry bulk recovery of at least 30%.

13. The absorbent product of any one of claims 1 to 12, wherein the web is a nonwoven fibrous web.

14. The absorbent product of any one of claims 1 to 13 wherein the fibers of the web are synthetic resilient fibres.

15. The absorbent product of claim 14, wherein the fibres of the web are polyethylene, polyester, polypropylene or polyamide fibres or a mixture thereof.

16. The absorbent product of any one of claims 1 to 14, wherein the fibres of the web are bicomponent fibers.

17. The absorbent structure of claim 6 or claim 10 or any claim dependent thereon, wherein the second layer is chemically delignified wood pulp fibers, peat moss, acrylic fibers, rayon fibers or a mixture thereof.

18. The absorbent product of claim 17, wherein the web is a layer of non-woven polyester fibres and the second layer is of chemically delignified wood pulp fibres.

19. The absorbent product of any one of claims 1 to 18, wherein said corrugated structure is stabilised by use of an adhesive.

20. The absorbent product of any one of claims 1 to 18, wherein said corrugated structure is stabilised by use of low melt fibres distributed in said fibrous web.

21. The absorbent product of any one of claims 1 to 20, further comprising a liquid impermeable barrier covering at least one side of said web and a liquid-permeable facing covering at least the other side of said web.

22. The absorbent product of claim 21 when dependent on any one of claims 1 to 8, wherein the superabsorbent is placed between the corrugated web and the liquid-impermeable barrier.

23. The absorbent product of claim 21 when dependent on any one of claims 1 to 8, wherein the superabsorbent is affixed to said liquid-impermeable barrier.

24. The absorbent product of any one of claims 21 to 23 in the form of a disposable diaper, a urinary pad or a sanitary napkin.

FIG-1

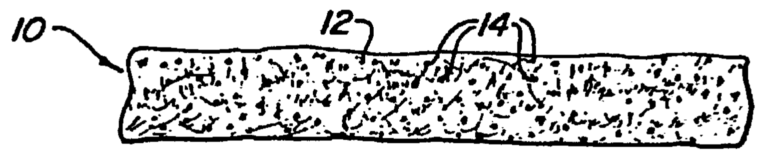


FIG-2

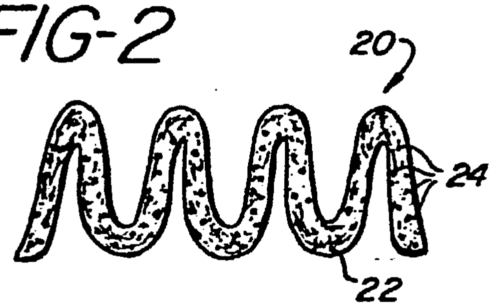


FIG-3

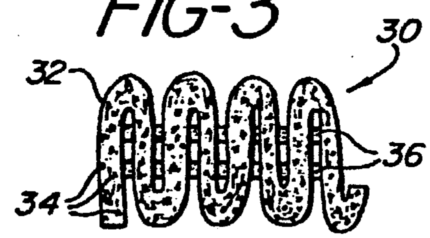


FIG-4

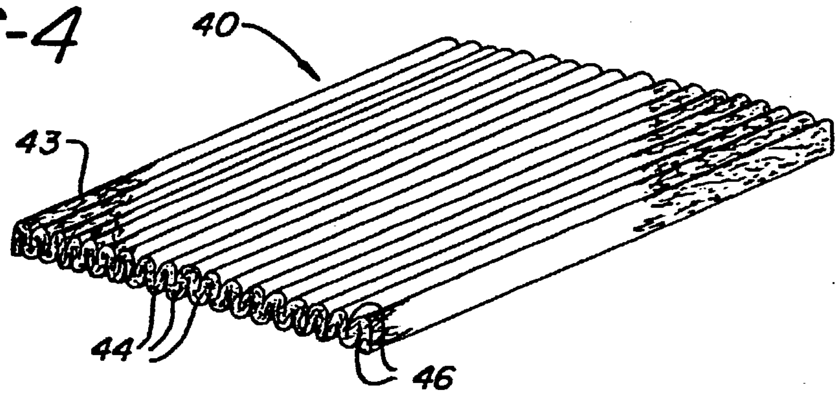


FIG-5

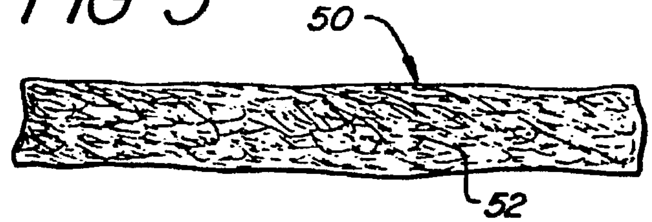


FIG-1A

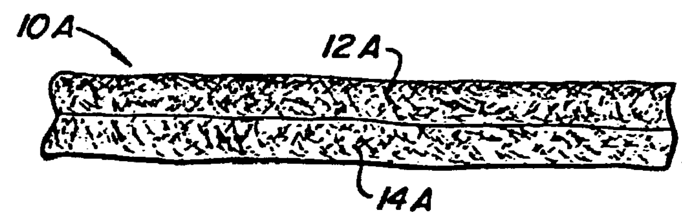


FIG-2A

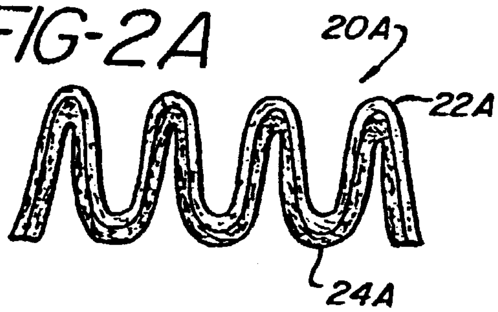


FIG-3A

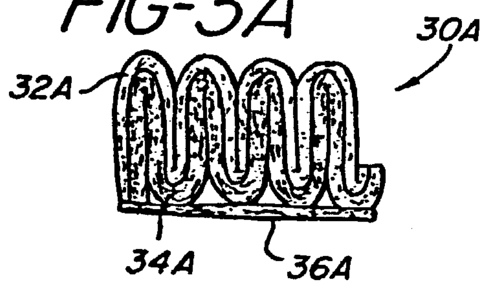


FIG-6

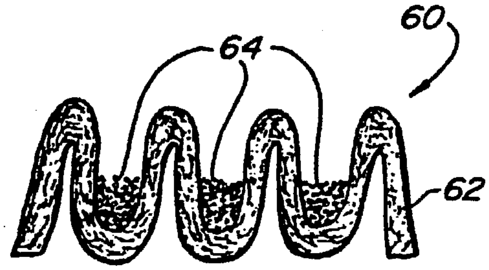


FIG-7

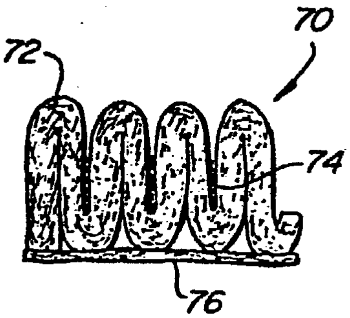


FIG-8

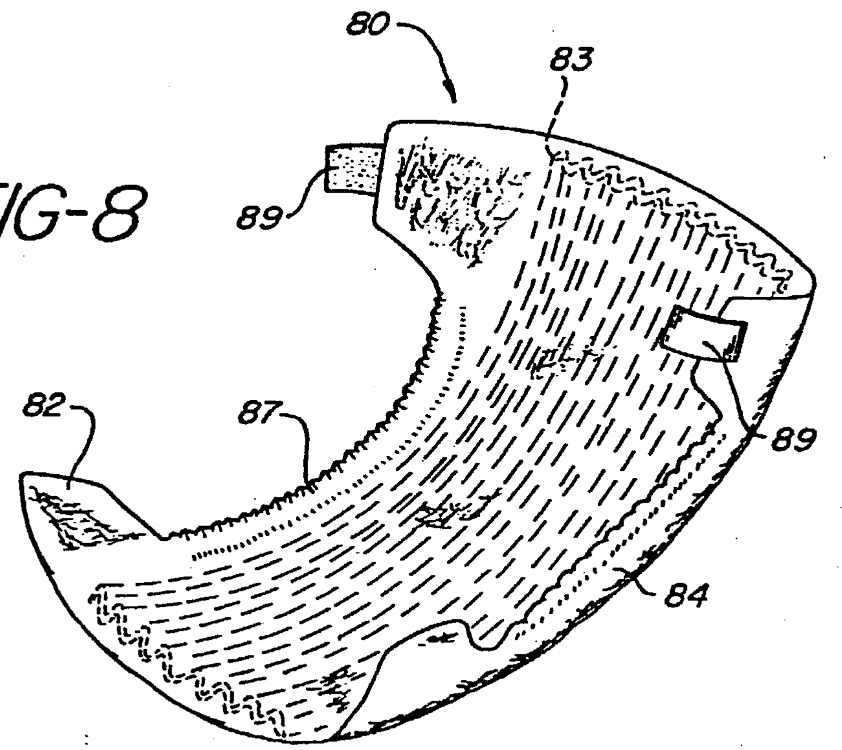
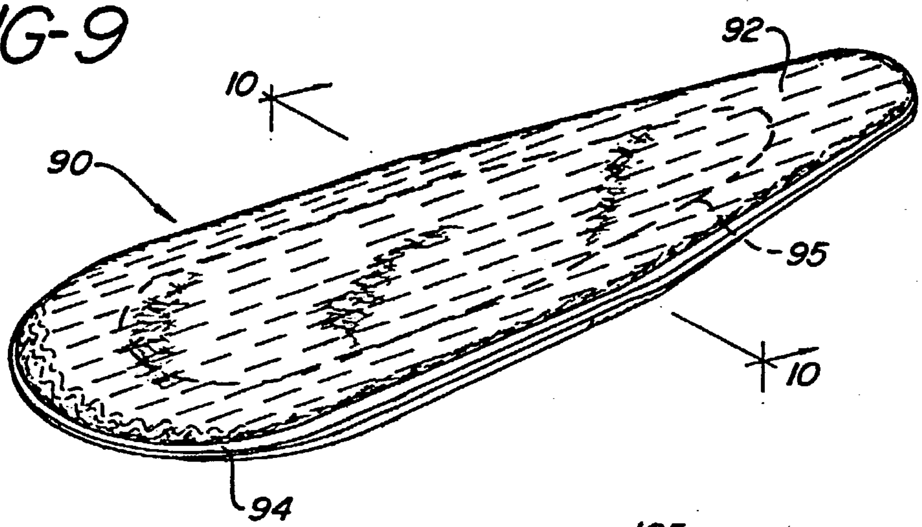


FIG-9



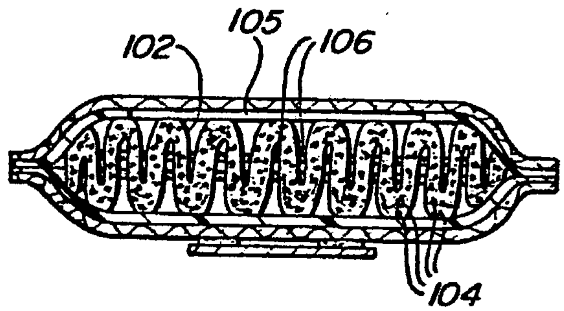
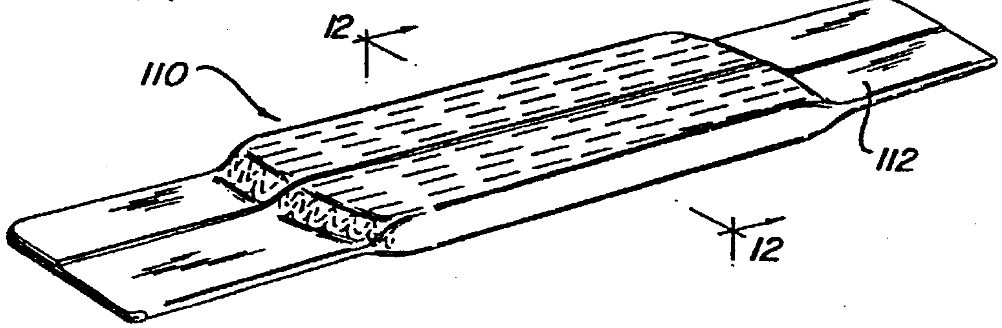


FIG-10

FIG-11



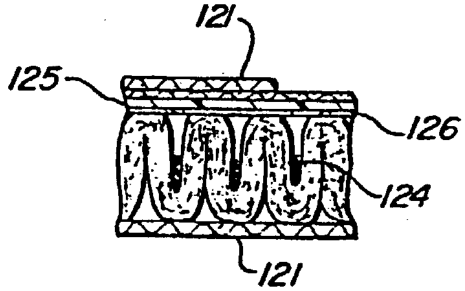


FIG-12

FIG-10A

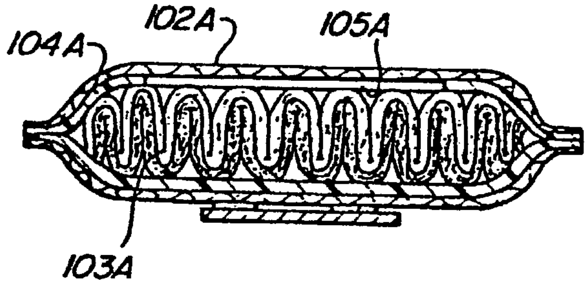


FIG-10B

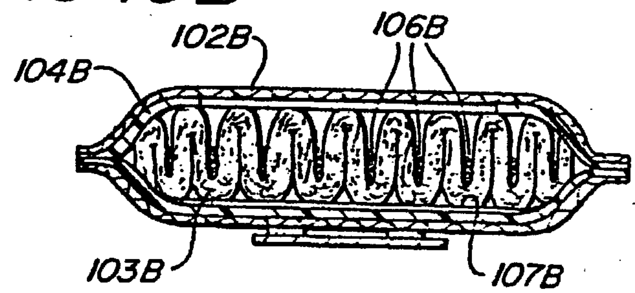


FIG-12A

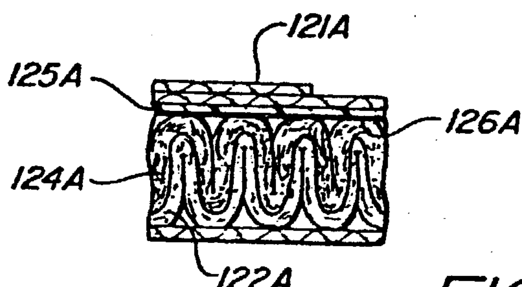


FIG-12B